

SUBJECT: Scientific Merits of Placing the  
Galactic X-ray Experiment (S-027/150)  
on the Lunar Module for the AAP-4  
Mission - Case 630

DATE: March 21, 1969

FROM: F. F. Tomblin

ABSTRACT

The potential scientific advantages of placing the Galactix X-ray Experiment on the ATM Lunar Module instead of the instrument unit of the S-IVB on the AAP-4 mission include:

- 1) a thorough sky scan may be performed covering more than one half of the celestial sphere;
- 2) the total viewing time may be extended, thus increasing the sensitivity of detection of stellar sources;
- 3) if two-degree-of-freedom pointing is available, the same source may be viewed many times during the 56 day mission;
- 4) daytime observations are possible.

Requirements imposed on the AAP-4 mission for LM/ATM mounting are:

- 1) 100 to 200 lbs additional weight will be required for extra gas supply, gimbaling and motor drive;
- 2) a deployment scheme which will provide protection for detectors during launch must be supplied;
- 3) a telemetry system similar to that now planned for the S-IVB will have to be transferred to the ATM.

If one or two degree of freedom cannot be supplied, the LM/ATM mount is less advantageous than the instrument unit mount presently planned.

(NASA-CR-103924) SCIENTIFIC MERITS OF  
PLACING THE GALACTIC X-RAY EXPERIMENT  
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MEMORANDUM FOR FILE

I. PURPOSE OF STUDY

This study was undertaken to determine the scientific advantages of placing the Galactic X-ray Astronomy experiment, currently planned for the instrument unit of the S-IVB, on the lunar module. This would allow the totally automated experiment to operate for 56 days or longer compared to only four hours on the instrument unit.

II. THE EXPERIMENT

This X-ray astronomy experiment is an array of gas filled proportional counters with an angular resolution of less than one degree of arc and a total effective area of  $1500 \text{ cm}^2$ .<sup>(1)</sup> The windows of the detectors are made of aluminized mylar thin enough to permit transmission of X-rays with energies down to 0.2KeV. The gas diffuses through the thin windows of the detectors, and pinholes are made to assure a nearly constant flow rate. A continuous gas supply keeps the pressure at about 1/3 atmosphere during the experiment operation. A constant gas density is required for proper operation of the proportional counters. To assure this, a density sensor is provided and appropriate pressure changes are made as the temperature varies.

The sky mapping will be performed by maintaining the S-IVB long axis aligned with the velocity vector. As the S-IVB orbits the velocity vector traces out a great circle on the celestial sphere. The experiment is mounted looking out the side of the S-IVB on the ATM shroud, next to the instrument unit cold plate. It will point normal to the velocity vector, always looking away from the earth. The field of view is such that in three orbits a region of the sky ranging from  $+30^\circ$  to  $-30^\circ$  from the orbital plane is scanned. This scan is performed by rotating the S-IVB  $20^\circ$  on each of the three orbits. Daytime measurements are not possible because at 105 nm, the altitude of the S-IVB, the X-rays generated by the solar radiation in the residual atmosphere inhibit the sensitivity to stellar X-ray sources.<sup>(2)</sup>

The detectors, gas supply, and electronics are currently estimated to weigh 257 lbs. Power required will be 85 watts and volume occupied will be about 8 cu. ft. <sup>(3)</sup>

This experiment is scientifically interesting because very few searches have been made for X-ray sources in this low energy region. Since the number of photons generated for most sources appears to increase with decreasing energy, it is possible that new sources will be found with this survey, which may be undetectable at higher energies.

### III. PLACEMENT ON LM

#### A. Field of View

The lunar module, along with the entire ATM workshop, is solar oriented. Thus, if the experiment is mounted to the LM some provision must be made for pointing in order to perform a sky survey.

At least one degree of freedom is necessary. The experiment could be mounted on the top of the lunar module as shown in Figure 1. Pointing should be at least  $\pm 60^\circ$  from the normal to the orbital plane in the plane normal to the ATM look direction. This motion combined with the  $6\frac{1}{2}^\circ$ /day precession of the  $35^\circ$  inclination orbit will allow the portion of the sky indicated in Figure 2 to be mapped from an altitude of 210 nm. Yet some viewing time near noon and midnight may be lost because the experiment would be constrained to look near the earth's atmosphere. Daytime measurements would be possible with the planned ATM orbit. More than half of the celestial sphere may be mapped in 56 days if continuous measurements are made, and if the detector can look anywhere within  $\pm 60^\circ$  from the normal to the orbital plane.

Much more of the celestial sphere would be accessible at any one time with two degrees of freedom. This is shown in Figure 3. No larger portion of the celestial sphere would be visible over the entire mission; however, particular sources could be viewed repeatedly or continuously for many days to check for any variability in intensity.

#### B. Gas Supply and Thermal Constraints

Because a continuous gas flow is needed, additional gas will have to be carried. The 56 day mission would require not more than one cubic foot of gas at 1800 psi. <sup>(2)</sup> This is

about four times that presently required for the four hour mission, and would add approximately 100 lbs to the weight estimate.

No thermal requirements are specified for the detectors, except that the star sensors must not exceed 150°C. (4) The detectors are mounted with little thermal connection to the instrument unit cold plate, but the power supply and tape recorder are held to temperatures between 50°F and 122°F by mounting them on the cold plate. Tests should be performed to find the upper temperature limit of the thin windows of the detectors. It is possible that this temperature will be exceeded if the detector housing is fully exposed to sunlight when mounted on the LM.

#### C. Gimballing and Telemetry

The present weight of the detector array is 115 lbs. The gimballing and additional support for one or two degree of freedom motion may double this weight (exclusive of the additional gas requirement). Telemetry provisions are currently being made for this experiment on the S-IVB. Such provisions would have to be transferred to the ATM for recording and telemetering data. The simplest procedure would be to operate in a pre-programmed pointing mode. If pointing at interesting sources is desired, manual control by astronauts would be preferred although this is not essential for the success of the mission.

#### D. Mounting

A gimballed pointing system would require that this experiment protrude at least 2-3 feet from the side of the LM. In addition, the detectors must be protected from heating during launch. Thus it appears likely that some automatic deployment device or EVA will be required to situate this experiment on the LM when in orbit.

#### IV. SUMMARY

The placement of the Galactic X-ray Mapping Experiment on the lunar module is highly desirable if one or two degree of freedom pointing is provided. Placement of the experiment on the lunar module in a fixed position is definitely less desirable than the presently planned instrument unit mounting.

Leaving the experiment on the instrument unit would probably provide data somewhat in excess of that available from rockets prior to 1972. However, if the lifetime of the stabilized flight portion of the S-IVB instrument unit becomes shorter than the presently planned three orbits, it is possible that the experiment mounted in a recoverable rocket could provide similar data prior to the AAP-4 launch.

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F. F. Tomblin

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Attachments  
References  
Figures 1-3

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REFERENCES

1. Proposal by University of Wisconsin (W. Kraushaar, Principal Investigator) for Galactic X-Ray Mapping, April 11, 1968.
2. Telephone Conversation, W. Kraushaar, February 17, 1969.
3. Experiment Implementation Plan S-150 Galactic X-Ray Mapping.
4. Telephone Conversation, Mr. V. Fogle MSFC, March 6, 1969.

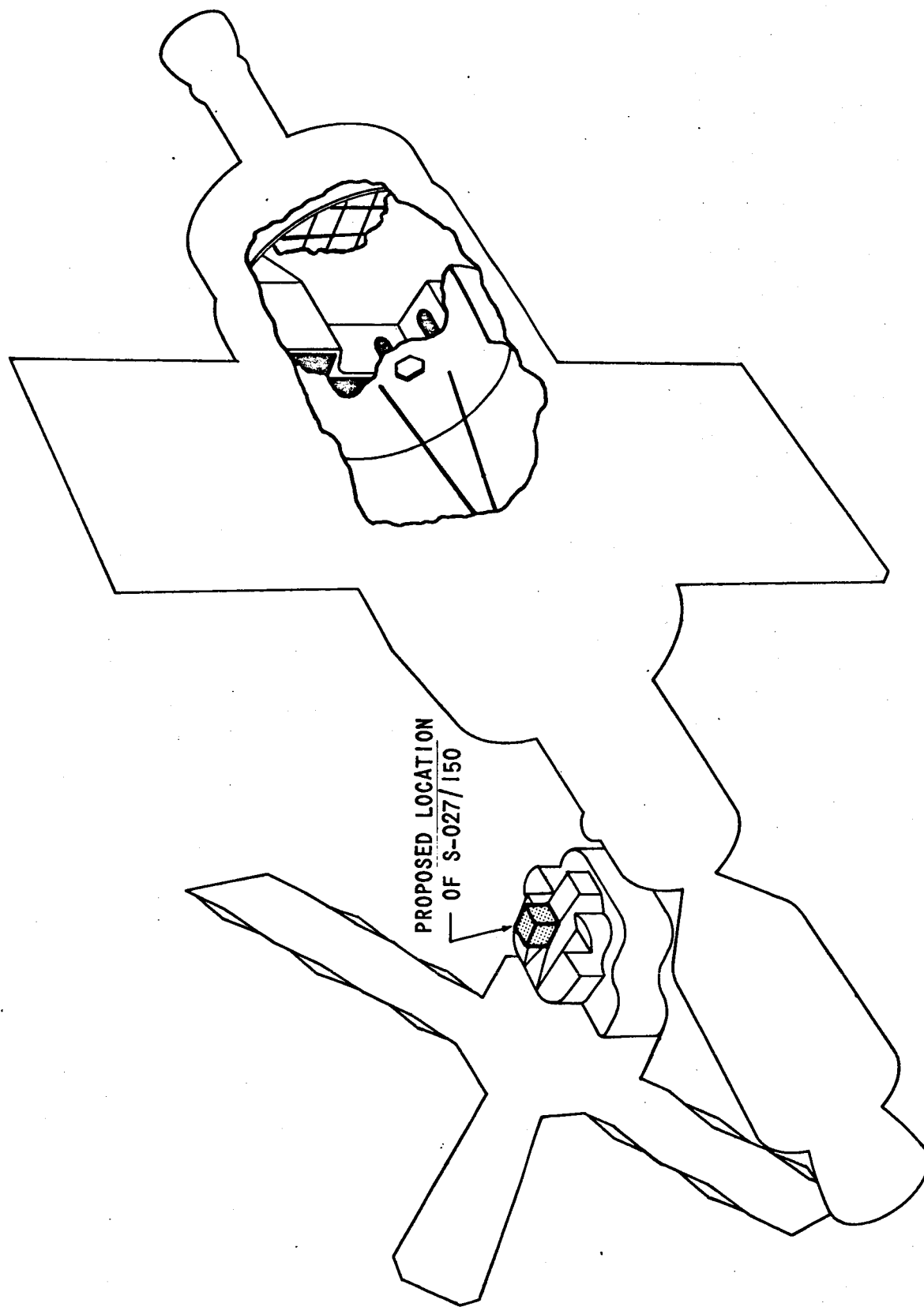


FIGURE 1 - PROPOSED LOCATION OF S-027/150 ON LM OF ATM WORKSHOP.

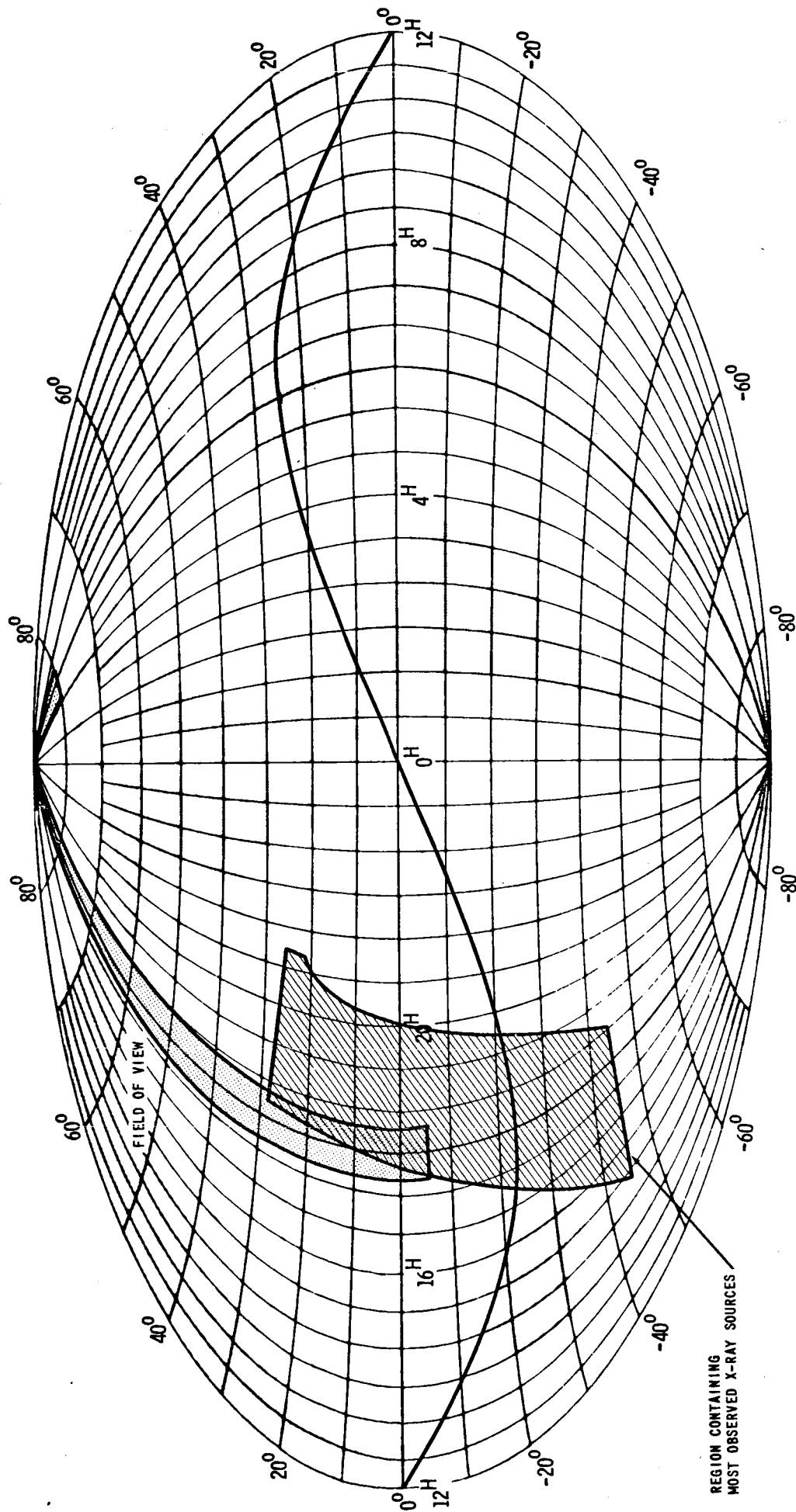


FIGURE 2 - CELESTIAL SPHERE SHOWING PORTION OBSERVED DURING ONE ORBIT BY POINTING  $\pm 60^\circ$  FROM THE NORMAL TO THE ORBITAL PLANE IN A PLANE NORMAL TO THE ATM LOOK DIRECTION. THE ENTIRE REGION ABOVE  $-5^\circ$  COULD BE MAPPED IN 56 DAYS AS THE FIELD OF VIEW ROTATES ABOUT THE NORTH CELESTIAL POLE.

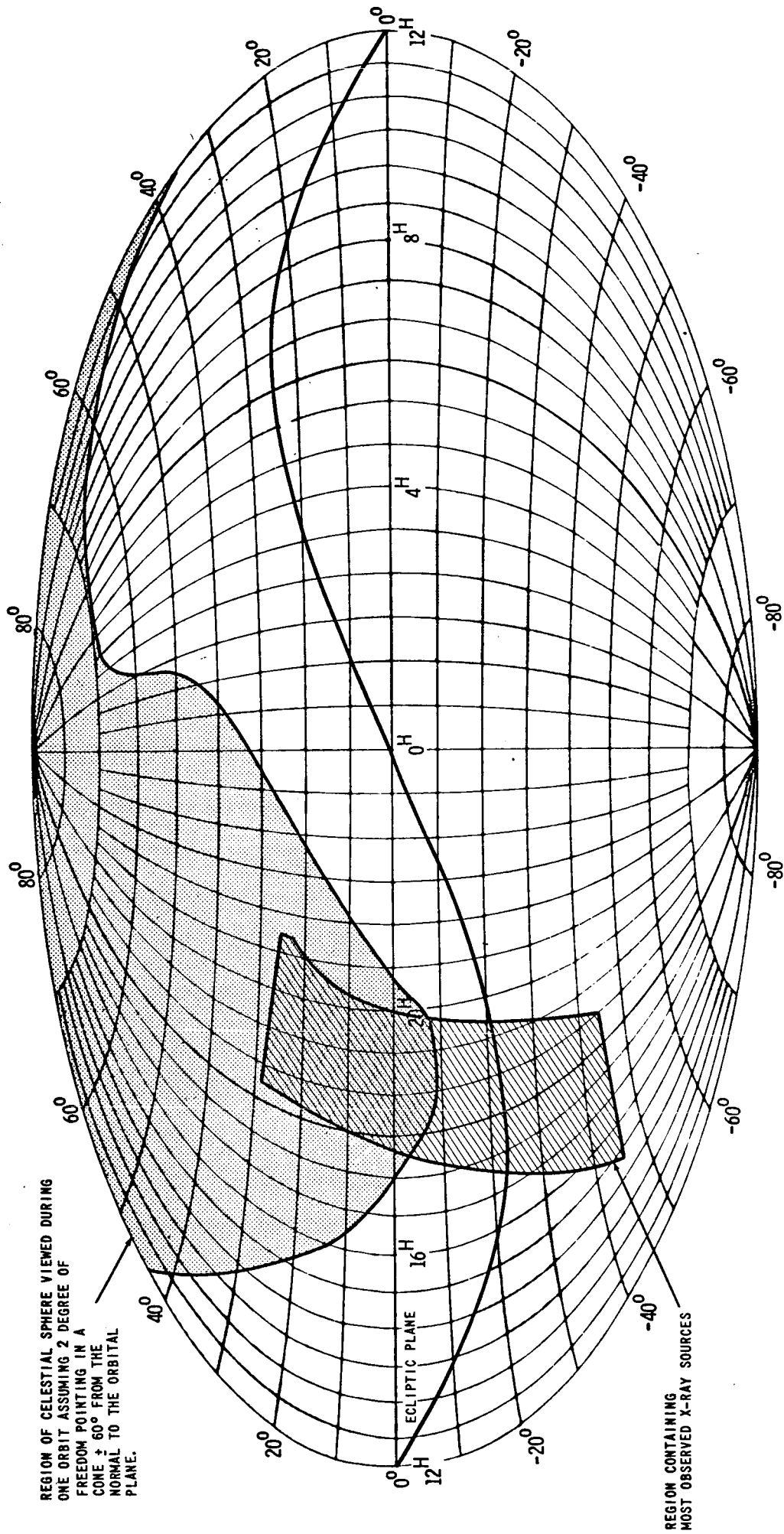


FIGURE 3 - THE PORTION OF THE CELESTIAL SPHERE VISIBLE DURING ONE ORBIT ASSUMING 2 DEGREE OF FREEDOM MOTION. THIS PORTION WILL MOVE ABOUT THE NORTH CELESTIAL POLE AT  $6 \frac{1}{2}^\circ/\text{DAY}$  AS THE ORBITAL NODE REGRESSES. THE ENTIRE UPPER HEMISPHERE COULD BE MAPPED IN 56 DAYS.

BELLCOMM, INC.

March 28, 1969

ERRATA

Please note the following correction to "Scientific Merits of Placing the Galactic X-ray Experiment (S-027/150) on the Lunar Module for the AAP-4 Mission," Case 630, Bellcomm Memorandum for File dated March 21, 1969.

The orbital altitude for the AAP-4 S-IVB was incorrectly stated as 105 nm. The currently planned orbit is 190 x 212 nm. Daytime x-ray measurements would therefore be possible with S-027/150 mounted on either the instrument unit of the S-IVB or the ATM Lunar Module.

The conclusions reached in the study remain unaffected by this.

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F. F. Tomblin

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